Referring now to FIG. **25**, an alternate embodiment of a directional energy applying catheter is presented. In this embodiment, a catheter **130** having an optical fiber diffusing tip **132** is used to directionally apply energy to a selected vascular segment. As shown, an optical fiber **134** is disposed within the catheter **130** and is connected at its distal end to a light diffusing device **136**, such as a sapphire crystal, to allow diffusion of optical energy; such as that produced by a LASER connected to the proximal end of the catheter. Additionally, the diffusing tip may have a reflector **138** to direct the optical energy toward the wall of the vein and away from the catheter lumen in which the optical fiber is located. Other light sources, such as a flash lamp may be used. A tip deflecting wire or strut **140** is shown in this embodiment to be deployed for placing the optical energy radiating tip **132** in apposition with the vein wall; however, other devices may be used for accurate placement of the energy source, such as a balloon shown in FIG. **20**. The outer sleeve **142** of the catheter is slidable. Sliding it toward the distal tip results in the strut **140** expanding and sliding the sleeve in the proximal direction results in the strut **140** contracting.

As can be readily ascertained from the disclosure herein, the surgical procedure of the present invention is accomplished without the need for prolonged hospitalization or post-operative recovery. The restoration of venous function is possible without the need for continued lifestyle changes, such as frequent leg elevation, the wearing of elastic support stockings, or prolonged treatment of recurrent venous stasis ulcers. Moreover, the need for surgery of the arm and leg for transplantation of arm veins into the leg would not be necessary.

Early treatment of venous disease could prevent more serious complications such as ulceration, and valve damage caused by thrombophlebitis or thromboembolism. The cost of treatment and complications due to venous disease would be significantly reduced. There would be no need for extensive hospitalization for this procedure, and the need for subsequent treatment and hospitalization would also be reduced from what is currently needed. Furthermore, the minimally invasive nature of the disclosed methods would allow the medical practitioner to repair or treat several vein sections in a single procedure in a relatively short period of time.

It is to be understood that the type and dimensions of the catheter and electrodes may be selected according to the size of the vein to be treated. Although the present invention has been described as treating venous insufficiency of the lower limb such as varicose veins in the leg, the present invention can be used to intraluminally treat venous insufficiency in other areas of the body. For example, hemorrhoids may be characterized as outpocketed varicose veins in the anal region. Traditional treatments include invasive surgery, elastic ring ligation, and the application of topical ointments. Shrinking the dilated veins using RF energy can be accomplished in accordance with the present invention. Specifically, the catheter and electrode combination is introduced into the venous system, into the external iliac vein, the internal iliac vein, then either the hemorrhoidal or the pudendal vein. The catheter then delivers the electrode to the site of the dilated hemorrhoidal, vein by this transvenous approach. Fluoroscopic techniques or any other suitable technique such as pulse-echo ultrasound, as previously discussed, can be used to properly position the electrode at the venous treatment site. The treatment site is preferably selected to be at least two centimeters above the dentate line to minimise pain. The electrode applies RF energy at a suitable frequency to minimized coagulation for a sufficient amount of time to shrink, stiffen, and fixate the vein, yet maintain venous function or valvular competency. This intraluminal approach avoids the risks and morbidity associated with more invasive surgical techniques such as hemorrhoidectomy, while significantly reducing reflux of blood in the area without necrosing or removing the venous tissue.

Another area of venous insufficiency relates to erectile impotency of the penis. A significant number of all physically-induced cases of impotence result from excessive drainage of blood from the penile venous system. Venous-drainage-impotence can be treated using the present invention. Catheters having a sufficiently small diameter can be used to deliver the electrodes through the dorsal vein of the penile venous system to shrink this venous outflow path. Fluoroscopic or ultrasound techniques can be used to properly position the electrode within the incompetent vein. RF energy or other radiant energy is applied from the electrodes at a suitable frequency to shrink the surrounding venous tissue in order to reduce the excessive amount of drainage from the penis while maintaining venous function or valvular competency. The amount of shrinkage of the vein can be limited by the diameter of the catheter itself, or the catheter or electrodes themselves can be expanded to the appropriate size. Ligation of these veins should be avoided so as to allow for the proper drainage of blood from an engorged penis which is necessary for proper penile function.

Another area of venous insufficiency suitable for treatment in accordance with the present invention involves esophageal varices. Varicose veins called esophageal varices can form in the venous system along the submucosa of the lower esophagus, and bleeding can occur from the swollen veins. Properly sized catheters can be used in accordance with the present invention to deliver the electrodes to the site of venous insufficiency along the esophageal varices. Endovascular access for the catheter is preferably provided through the superior mesenteric vein or portal vein to shrink the portal vein branches leading to the lower esophagus. Proper positioning of the electrode within the vein can be confirmed using fluoroscopic or ultrasound techniques. The electrodes apply RF energy or other radiant energy at a suitable frequency to shrink the vein and reduce the swelling and transmission of high portal venous pressure to the veins surrounding the esophagus.

While several particular forms of the invention have been illustrated and described, it will be apparent that various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited, except as by the appended claims.

The invention claimed is:

1. A method comprising:

inserting an optical fiber transluminally through a lumen of a vein;

positioning a distal end of the optical fiber at a treatment site in the lumen of the vein;

approximating the distal end of the optical fiber and an inner wall of the vein, at the treatment site;

applying light energy from the optical fiber to the inner wall of the vein at the treatment site, and thereby shrinking the vein at the treatment site; and

inserting a tubular member transluminally into the vein;

wherein

applying light energy comprises applying light energy from the distal end of the optical fiber while the distal end of the optical fiber is positioned within the tubular member;

the tubular member comprises a first material portion and a second material portion located in a distal region